

## **HEMI-SYNC® AND THE SLEEP STATE**

*by F. Holmes Atwater*

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### **BACKGROUND**

The Monroe Institute's Natural Sleep Processor (NSP-1) is a solid state, microprocessor-based electronic device which produces Hemi-Sync sound patterns designed to induce natural sleep cycles. To evaluate the efficacy of this device, electroencephalographic (EEG) recordings of volunteers were taken before and while listening to the NSP-1 prototype. Over the years, sleep has been the subject of study with EEG recordings and, although meticulous measurements of the sleep process require monitoring of eye movement, facial muscles, and certain other parameters, EEG brain-wave patterns are still relied on as indicators of changes of consciousness associated with sleep.

### **PROCEDURE AND METHOD**

After attaching surface electrodes at positions FP1, FP2, C3, and C4 (International 10/20 system) to volunteers' heads, they were connected to a computerized EEG recording device, the Lexicor Neurosearch-24, which provided EEG data acquisition, analysis, and display. Volunteers lay on a waterbed in an enclosed chamber isolated from distractions and the evaluators and their computer monitors. Volunteers were instructed to attend to sounds over a period of ninety minutes. These sounds were produced by the NSP-1 and heard through piezoelectric earphones. A series of EEG recordings was made according to the following protocol: 1. Five minutes of baseline recording before turning on the NSP-1; 2. Five minutes recording of the five minutes after turning on the NSP-1; 3. Five minutes recording at fifteen minutes after turning on the NSP-1; 4. Five minutes recording at twenty-five minutes after turning on the NSP-1; 5. Five minutes recording at forty minutes after turning on the NSP-1; and 6. Five minutes recording at sixty minutes after turning on the NSP-1. All EEG data was recorded and saved on an IBM compatible 386 AT in raw form accessible only by Lexicor's proprietary software and hardware.

## VOLUNTEERS

The volunteer pool included adult males and females, aged twenty to sixty. None of the volunteers had clinically diagnosed sleep disorders. Familiarity with Hemi-Sync ranged from naive to adept. Volunteers participated in evaluation trials both midmorning (approximately 10:00 AM) and midafternoon (approximately 2:00 PM).

## DATA ANALYSIS

All data was screened for movement artifacts: those epochs demonstrating artifact levels were discarded from analysis. For each volunteer's data, each five-minute recording period was then subjected to a trend analysis of the EEG activity at sites C3 and C4 to determine the fluctuations of individual frequency bands of interest over time. The trend was computed by taking the fast Fourier transform (FFT) of a single epoch of data, then summing the values within the range of frequencies corresponding to each band. Percent average power ( $\mu V^2$  pp) of delta (1-4Hz), theta (4-8Hz), alpha (8- 12Hz), and beta (12-16Hz) was computed. The individual five-minute trends were then examined for archetypal epochs reflecting recognized patterns associated with different sleep states. When identified, these archetypal epochs were analyzed in raw form; the percent average power of each frequency band of interest was then quantified.

An ancillary spectral analysis was conducted to evaluate the extent of brain-wave frequency following response (FFR) to the binaural beat frequencies presented in the NSP-1 Hemi-Sync sounds. Five minutes average power at the C3 electrode was calculated for frequencies from 1 to 16 Hz for each of the five-minute recording periods and graphically plotted. Each of the five-minute averaged spectral plots, which represented different binaural beat stimuli from the NSP-1, were compared. Spectral plots for the archetypal epochs were also constructed and examined.

## RESULTS

Volunteers slept during the evaluation process. Trend analysis of each five-minute recording period in each volunteer's data confirmed standard EEG frequencies associated with sleep. Baseline recordings taken before turning on the NSP-1 consistently evidenced higher percent average power of alpha as compared with later recordings when volunteers were asleep and listening to the NSP-1. EEG brainwave patterns reflecting different sleep states were easily identified.

The ancillary spectral analysis demonstrated evidence of a frequency following response to the binaural beat frequencies produced by the NSP-1.

## DISCUSSION

The rate of descent and degree of depth into the non-REM sleep stages varied from one individual to another. Also, the amount of time spent in the various sleep stages varied from one volunteer to another. A few of the volunteers awoke during the evaluation process, only to return quickly to sleep. When questioned, this group related that they had been awakened by soreness associated with electrode placement.

This NSP-1 evaluation used a natural ninety-minute nocturnal sleep cycle (the NSP-1 Hemi-Sync-produced environment) applied to volunteers during normal waking hours. The NSP-1 is programmed for nocturnal sleep patterns, not daytime naps. Evaluation volunteers, however, fell asleep when presented with this Hemi-Sync environment.

## SUMMARY

Careful laboratory evaluation of the NSP-1 cogently demonstrates that natural sleep can be induced during normal waking hours with specially engineered, sequentially presented sound patterns developed by The Monroe Institute. This finding supports the hypothesis that consistent use of the NSP-1 during nocturnal sleep fosters the production of natural sleep cycles.

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